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230603 - TSF - Telecommunication Systems Fundamentals

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Perez Romero, Jorge

Others: Gene Bernaus, Juan Manuel
Perez Romero, Jorge

Prior skills

Basic background on Digital Communications, Electromagnetic Radiation and Propagation, Guided EM Waves

Degree competences to which the subject contributes

Specific:

1. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
2. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
3. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals

Transversal:

4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Teaching methodology

- Lectures
- Application classes
- Individual homework
- Short answer test (Control)
- Extended answer test (Final Exam)

Learning objectives of the subject

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The aim of this course is to present the basic fundamentals of the communication systems for both wired and wireless systems
In the case of wireless systems this course particularly addresses the study, design and evaluation of the basic features of mobile communication systems.
In the case of wired systems this course provides basic background on the field of fiber-optic communication systems. In particular, a brief review of the most fundamental devices, namely optical fibers, laser diodes, photodetectors, optical modulators, and optical amplifiers, will give the students the basic knowhow on their functionalities and operation from a system's perspective. Another goal of this course is to get the students acquainted with the quality parameters of an optical transmission like signal-to-noise ratio (SNR) or bit error rate (BER).

Learning results of the subject:

- Ability to design and evaluate the fundamental communication techniques for networks, services and applications in mobile telecommunications environments.
- Ability to identify and model complex radio systems.
- Ability to identify the most relevant parameters of optical fibers, laser diodes, photodiodes, optical modulators, and optical amplifiers and to operate such devices.
- Ability to analyse and design a basic fiber-optic communications system, including the estimation of both the SNR and BER for optical data transmission systems.
- Ability to design and develop mobile communication systems, including channel modeling, link budget and dimensioning.
- Ability to design and develop copper-based cable and optical fiber systems for communication purposes.
- Ability to apply advanced knowledge in photonics and optoelectronics.

Study load

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

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Content

1. Introduction to cable transmission

Learning time: 2h

Theory classes: 1h
Self study : 1h

Description:
- Evolution of cable telecommunication systems
- Conductor line technology and applications
- Evolution of fiber-optic based telecommunication systems

2. Optical Fibers

Learning time: 17h

Theory classes: 5h
Self study : 12h

Description:
- Basic propagation light guiding concepts
- Single-mode and multimode fibers
- Attenuation and dispersion
- Other physical transmission impairments
- Performance of fiber optics

3. Optical Transmitters

Learning time: 14h

Theory classes: 4h
Self study : 10h

Description:
- Basics on laser semiconductors
- Lasers for optical fiber communications
- Modulation of light properties
- Optical Intensity modulation
- Carrier modulation formats
- Optical transceiver modules
- WDM optical transmitters

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4. Optical Receivers

Learning time: 14h

Theory classes: 4h
Self study : 10h

Description:
- Basics on photodetectors
- PIN and APD photodetectors
- Photodetection noise
- Optical detection techniques
- Receiver sensitivity

5. Optical Amplifiers

Learning time: 7h 30m

Theory classes: 2h 30m
Self study : 5h

Description:
- Semiconductor optical amplifiers (SOA)
- Erbium-doped fiber amplifiers (EDFA)
- System applications

6. Optical Fiber Telecommunication Systems

Learning time: 8h

Theory classes: 3h
Self study : 5h

Description:
- Intensity modulation/direct detection
- Coherent systems
- Wavelength Division Multiplexed (WDM) networks

7. Introduction to mobile communications systems

Learning time: 2h

Theory classes: 1h
Self study : 1h

Description:
- Definitions
- Types of Radiocommunication systems
- Mobile communications: Systems and technologies

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8. Characterisation of the mobile radio channel	Learning time: 11h Theory classes: 3h Self study : 8h

Description:
- Introduction
- Propagation in the mobile environment (Path Loss, Slow fading, Multi-path propagation)
- Noise
- Interference

9. Link Budget and Radio Engineering techniques	Learning time: 12h 30m Theory classes: 3h 30m Self study : 9h

Description:
- Quality target
- Performance model of the radio link
- Link budget
- Radio engineering techniques
  - Power control
  - Channel coding and interleaving
  - Diversity
  - Spatial Multiplexing

10. Mobile Radio Access	Learning time: 18h Theory classes: 6h Self study : 12h

Description:
- Introduction
- Multiple access techniques (FDMA, TDMA, CDMA, OFDMA)
- Duplexing techniques (FDD, TDD)
- Mobile radio access management

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11. Cellular Systems	Learning time: 19h Theory classes: 6h Self study : 13h

Description:
- Model of a cellular system
- Control and management of cellular systems
- Dimensioning of a cellular system
- Dimensioning of FDMA/TDMA cellular systems
- Dimensioning of CDMA cellular systems
- Multi-layer cellular structures

Qualification system

Final examination: 50%
Partial examinations and Delivery of Exercises: 50%

Bibliography

Basic:

Keiser, G. Optical fiber communications. 4th ed. New York: McGraw-Hill, 2011. ISBN 9780073380711.

Sallent Roig, O.; Pérez Romero, J. Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares [on line]. Barcelona: Iniciativa Digital Politècnica, UPC, 2014 [Consultation: 03/10/2014]. Available on: <http://hdl.handle.net/2099.3/36630>. ISBN 978-84-9880-482-9.

Lee, W.C.Y. Mobile Communications Design Fundamentals. 2nd. ed. John Wiley & Sons, 1993. ISBN 0471574465.

Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2nd ed. New York [etc.]: John Wiley & Sons, 2007. ISBN 9780471358329.

Senior, J.M. Optical fiber communications: principles and practice. 3rd ed. New York: Prentice Hall, 2008. ISBN 9780130326812.

Complementary:

Hernando Rábanos, J.M.; Riera Salís, J.M.; Mendo Tomás, L. Transmisión por radio. 7a ed. Madrid: Centro de Estudios Ramon Areces, 2013. ISBN 9788499611068.

Agrawal, G.P. Lightwave technology: components and devices. Hoboken, NJ: Wiley Interscience, 2004. ISBN 0-471-21573-2.